OFFICE ROOM THERMAL MODEL

Description of task

The thermal behaviour of an air-conditioned office room is investigated by using a lumped parameter thermal model. The internal measures of the room are: height 3 m, width and length both 4 m. The three-pane window on the external wall is 1,5 m high, 4 m wide and has an U-value (between outdoor air and indoor air) 1,0 W/m^{2}K. The structure of the external wall starting from outside is 130 mm brick, 300 mm mineral wool and 130 mm brick. The ceiling and floor are 200 mm thick hollow concrete slabs with 140 mm diameter hollows, centreline distance 170 mm. The floor is covered with a 10 mm thick cork slab. All other three internal walls are made of 130 mm brick.

The outdoor air temperature has a diurnal sinusoidal variation between 15 ^{o}C and 25 ^{o}C the maximum occurring at 3 pm. The window facing towards East is exposed to direct solar radiation between 4 am and noon. The intensity of radiation is changing according to the positive part of a sine curve and having maximum of 500 W/m^2 at 8 am. The cooling load of lighting, machines and people is 40 W/m^2 between 8 am and 4 pm. The flow rate of ventilation is 3 dm^3/s m^2 between 8 am and 4 pm. The supply air temperature is 2 ^{o}C higher than the outdoor air temperature. The temperatures of the adjacent rooms have identical temperatures with the room under investigation.

Construct a thermal model of the room with 20…30 heat capacities. Using this model, calculate the diurnal variation of the indoor air temperature and the temperatures of other node points in case half of the direct solar radiation exposure is penetrating into the room. Compute also the temperatures in case of a shaded window, which cuts the solar penetration further into half of the previous case and has the ventilation on all time. Calculate further for both previous cases the hourly cooling power needed to keep the room air temperature between a lower limit of 21 ^{o}C and a upper limit of 24 ^{o}C. The radiation exchange between internal room surfaces can be ignored. To solve the equations use the finite-difference method with suitably chosen parameter values to achieve optimal accuracy and stability.

Write a report describing the work. The report should include a detailed description of the model, equations and mathematical solution as well as parameters chosen for the computation. Results include the temperatures in each node point as a function of time for each case. An analysis of the results and conclusions are necessary as well. A listing of the computation code is added as an appendix.